The Role Of Artificial Intelligence Modules In Developing Digital Competence Of Future Teachers

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Abstract

The sustainable development of the education system in the context of digital transformation directly depends on the digital competence of future teachers. This article comprehensively studies the pedagogical capabilities, functional characteristics and impact of artificial intelligence (AI) modules on the formation and development of digital competence of future teachers. The study revealed the effectiveness of artificial intelligence-based adaptive learning, analysis of learning activities, automated assessment and the formation of individual educational trajectories. Experimental results showed that the use of artificial intelligence modules significantly develops the cognitive, operational and reflexive components of the digital competence of future teachers. At the end of the study, scientifically based conclusions and practical recommendations were developed for the higher pedagogical education system.

Keywords: Digital competence, artificial intelligence, future teacher, adaptive education, digital pedagogy.

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1. Introduction

In today's globalization and digital transformation, one of the important tasks facing the education system is to train pedagogical personnel who can work with digital technologies, analyze information, and develop innovative pedagogical solutions. In particular, the rapid introduction of artificial intelligence technologies into the educational process requires new competencies in the professional activities of educators.

"Digital competence" has become one of the main professional qualities of a modern educator, including not only the practical use of digital tools, but also the ability to think critically, information security, and effective communication in a digital environment [1]. Although reforms aimed at digitalization are being carried out in the education system of Uzbekistan, traditional approaches still prevail in preparing future educators for the requirements of the digital age [2].

The issue of developing digital competence of educators has been widely covered in foreign scientific research. In particular, the DigCompEdu model developed by Redecker proposes to assess and develop a teacher's digital competence in six main areas [3]. Holmes, Luckin and Fadel argued that the use of artificial intelligence

technologies in the educational process enhances the person-centeredness of the pedagogical process [4, 5].

The scientific works of Uzbek scientists also cover the issues of digital learning tools, e-learning, distance and blended learning [6, 7]. However, these studies do not sufficiently reveal the role of artificial intelligence modules in the formation of digital competence of future teachers based on a systematic and modular approach.

Therefore, this study analyzes the pedagogical capabilities of artificial intelligence modules, their impact on digital competence components and their effectiveness in the educational process from the author's point of view on a scientific basis. The main difference of the study is that it considers artificial intelligence modules as a central didactic tool for the development of digital competence.

2. Methods

The study was conducted with the participation of future teachers studying at a higher pedagogical educational institution and was aimed at determining the pedagogical effectiveness of artificial intelligence modules in developing the digital competence of future teachers. The study was based on an experimental and comparative-analytical approach, which included the stages of theoretical analysis, practical testing and generalization of results.

The study was carried out in several logical sequential stages. At the initial stage, the current state of digital competence of future teachers was determined, and initial indicators were determined using diagnostic tests and questionnaires. At the next stage, artificial intelligence modules were introduced into the educational process, and classes based on adaptive learning, automated assessment and individual learning trajectories were organized in the experimental group. At the final stage, the results of the experimental and control groups were compared and the data obtained were processed using mathematical and statistical methods, and scientific conclusions were drawn.
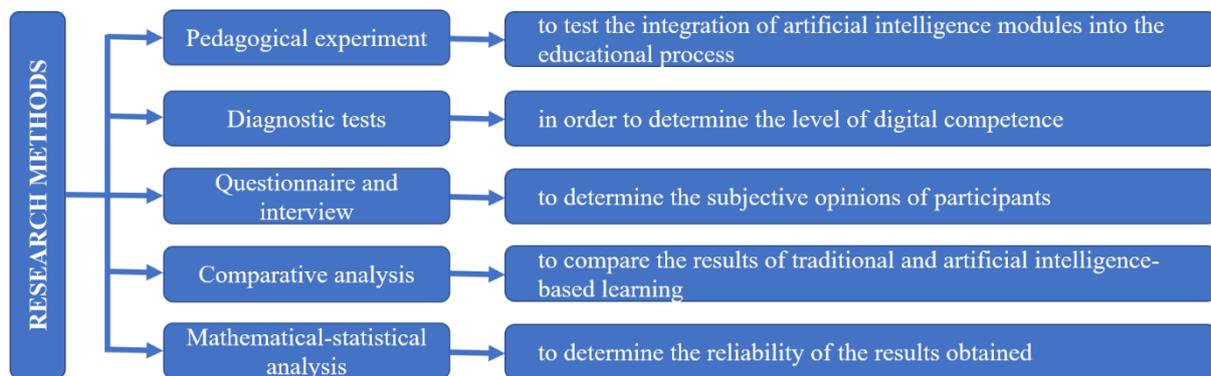
Figure 1. Methods used in the study

The following artificial intelligence modules were selected during the research process:
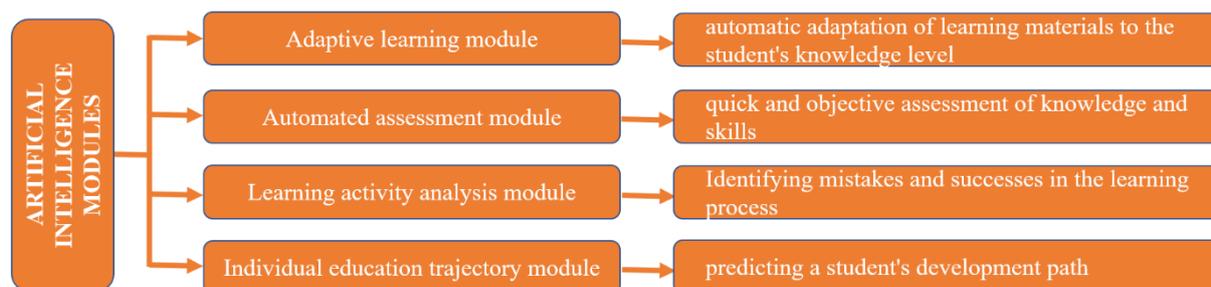
Figure 2. Artificial intelligence modules used in the study

These modules were selected as the most optimal solution among existing digital learning tools, as they allow for the comprehensive development of teachers' digital competence.

During the research process, artificial intelligence modules that ensure the comprehensive development of future teachers' digital competence were selected based on a systematic approach. In particular, an adaptive learning module was introduced to adapt the educational process to the individual capabilities and level of knowledge of the student. This module serves to ensure personalized education by analyzing educational materials in real time and presenting them in accordance with the student's level of mastery.

Also, an automated assessment module was used to reduce subjectivity in the process of assessing knowledge and skills and to obtain quick and objective results. This module analyzes the results of students' educational activities, allows them to identify their strengths and weaknesses, and increases the transparency of the assessment process. In order to deeply analyze the learning process, the learning activity analysis module was integrated, which served to optimize the learning process by identifying errors, problem areas and achievements of students in their learning activities. In addition, the module for forming an individual learning trajectory was used to predict the dynamics of the development of the student's knowledge and skills and determine the individual development path. With the help of this module, a flexible learning plan was developed for each student, which increased their learning motivation and independent learning activity. In general, the selected artificial intelligence modules served as a single, interconnected pedagogical system for developing the digital competence of future teachers.

3. Results

The results of the study showed that the educational process based on artificial intelligence modules has a significant positive effect on the development of digital competence of future teachers. As a result of the analysis conducted in the experimental group, positive dynamic changes were noted in all structural components of digital competence. In particular, the high growth observed in the operational component indicates the development of future teachers' skills in the independent and effective use of digital tools, working with artificial intelligence-based systems, and managing the educational process in a digital environment. At the same time, the high level of growth in the reflexive component confirms the formation of the abilities of future teachers to analyze their professional activities, identify problems arising in the process of using digital technologies, and make informed decisions to eliminate them. This fact scientifically confirms that artificial intelligence modules are an important didactic tool in the development of not only technical skills, but also pedagogical thinking and professional reflection.

Table 1.

Comparative analysis of digital competence components

Competency component	Traditional education (%)	Based on AI modules (%)
Cognitive	63	82
Operational	57	85
Reflexive	54	80

The results obtained show that the use of artificial intelligence modules activates the independent learning activities of future teachers, forms competencies in the conscious and purposeful use of digital tools, and develops the ability to systematically analyze their professional activities. In particular, adaptive and analytical modules based on artificial intelligence made it possible to identify individual learning needs of students, assess the learning process in real time, and form a reflective approach to educational activities. As a result, future teachers developed competencies to independently improve their knowledge and skills, make

decisions based on pedagogical problems arising in the digital environment, and consciously plan their professional development. The results of the conducted mathematical and statistical analysis confirmed that the differences noted between the experimental and control groups were not accidental and that they were statistically reliable. In particular, the data obtained were processed using parametric and nonparametric analysis methods, and the results were checked based on the Student t-test and χ^2 (chi-square) criteria. During the calculations, a reliability level of $p < 0.05$ was determined, which indicated that the positive impact of the educational process based on artificial intelligence modules on the digital competence of future teachers was of high statistical significance. This fact confirms the reliability of the research results, their generalizability and applicability to pedagogical practice on a scientific basis.

4. Discussion

The results of the study showed a high level of agreement with the conclusions presented in foreign scientific literature. In particular, the research conducted by Holmes and co-authors scientifically emphasized the enrichment of the educational process with flexible, person-oriented and data-based management mechanisms of artificial intelligence technologies [4]. The results of this study also confirmed these conclusions and showed that the use of artificial intelligence modules expands the ability to identify the individual learning needs of future educators, provide educational resources appropriate to their level of knowledge, and analyze educational activities in real time. In particular, the increase in the effectiveness of person-oriented education demonstrated that artificial intelligence modules are an important tool for ensuring differential and adaptive approaches in the pedagogical process. This was clearly manifested in the increased activity of future educators, their motivation for independent learning, and their need for self-development. At the same time, the research results show that artificial intelligence modules have great potential not only technologically, but also didactic and methodologically.

However, some limitations were also identified during the research process. In particular, it was observed that the level of effective use of artificial intelligence modules is directly dependent on the initial digital literacy of educators and experience working with technologies. It was found that participants with insufficient digital preparation had certain difficulties in using artificial intelligence tools, which to some extent affected the stability of the results. This situation indicates the need for targeted training of educators before introducing artificial intelligence technologies.

Also, the lack of in-depth analysis of the ethical, psychological and social aspects of artificial intelligence technologies within the framework of the research is noted as a certain limitation. In particular, issues such as data security, protection of personal information, algorithmic impartiality and transparency of artificial intelligence decisions should be considered as separate scientific problems in future research. In this regard, it is considered appropriate to conduct future research covering a wider audience, across different pedagogical areas and educational institutions, as well as to determine the long-term pedagogical effectiveness of artificial intelligence modules. In addition, the integration of artificial intelligence technologies with pedagogical principles, in particular, the principles of person-centeredness, systematicity, and continuity, can be considered a promising direction for future research.

5. Conclusion

The results of the study confirmed on a scientific basis that the use of artificial intelligence modules in the process of developing the digital competence of future teachers has high pedagogical effectiveness. The main goal set at the beginning of the study - to identify the didactic potential of artificial intelligence modules in the formation and development of the digital competence of future teachers - was fully realized. During the study, it was found that artificial intelligence modules are not only a technological tool, but also an important pedagogical mechanism that serves to organize the educational process on a person-oriented, flexible and analytical basis.

The results of the study showed that artificial intelligence modules have a comprehensive impact on the development of all structural components of the digital competence of future teachers - cognitive, operational and reflexive aspects. In particular, the use of adaptive learning, automated assessment and the formation of individual educational trajectories modules strengthened the abilities of future teachers to learn independently, use digital tools consciously and analyze their professional activities. This fact scientifically confirms that artificial intelligence modules are an important didactic tool in the development of digital competence.

The practical significance of the study is that its results allow us to develop scientifically based recommendations on the introduction of artificial intelligence technologies in the higher pedagogical education system. In particular, by gradually introducing artificial intelligence modules in higher pedagogical education institutions, it is possible to increase the efficiency of the educational process and train future teachers in accordance with the requirements of the modern digital environment. At the same time, there is a need to develop special training courses and advanced training programs aimed at preparing teachers to work with artificial intelligence technologies.

In addition, the creation of automated digital competence assessment systems and their integration into the educational process allows for an objective and accurate assessment of the results of pedagogical activity. Such systems serve to monitor the digital competence of teachers, analyze the dynamics of their development, and determine individual professional development paths. In general, the results of this study serve as a solid scientific and methodological basis for the widespread introduction of artificial intelligence modules into the pedagogical education system and identify promising directions for future research.

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